METHOD OF FORMING A FLEXIBLE CIRCUIT BOARD

This application is a continuation of application Ser. No. 10/128,354, filed Apr. 24, 2002, pending.

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The invention relates in general to a method of forming a flexible circuit board, and more particularly to a method of fabricating a flexible circuit board by using photo-polymer.

Description of the Related Art

[0002] Flexible circuit boards used in the cartridge of an ink-jet printer serve as medium to lead the driving current to the chip for ink jetting. The driving current drives the cartridge and enables the cartridge to jet ink.

[0003] FIG. 1 shows a conventional flexible circuit board and its relative position to the dimple of the printer. Polyimide (PI) is a commonly used substrate 104 for the conventional flexible circuit board. Copper (Cu) and gold (Au) are two widely used materials for the conductive traces 106 in the flexible circuit board. The dimples 110 of the printer circuit contact the conductive traces 106 through holes 108 formed by tape automated bonding (TAB).

[0004] Etching and punching are two typical TAB manufacturing processes. Etching process is characterized by etching the tape while the punching process is characterized by punching the tape to form the holes.

[0005] FIG. 2A ~ FIG. 2J illustrate the conventional etching process. On the substrate 202, such as polyimide (PI), a copper film 204 with a thickness of about 100 Å is formed by sputtering. On the bottom side of the substrate 202 and over the copper film 204, photo-resistors (PR) 206 are formed. After exposing and developing the PRs 206, the patterns of the holes and the conductive traces are defined. Next, as shown in FIG. 2F, on the front side of substrate 202 with the exposed copper film 204, a copper layer 208 with several μm is plated. Then, as shown is FIG. 2G, the substrate 202 is etched to form the holes 210 at the bottom side of substrate 202. Then, the photo-resistors at both sides of substrate 202 are then removed, and the configuration is presented FIG. 2H. The following step as shown in FIG. 2I is a photolithography process, including steps of forming a photo-resister layer, exposing, developing and etching, to remove parts of the copper film 204 that are not protected by the copper layer 208. Finally, as shown in FIG. 2J, an insulation layer 212 is formed over the copper layer 208 for the purpose of protection and electrical insulation. Noted that the configuration of the holes 210 and the copper layer 208 are performed at the opposite sides of the substrate 202.

[0006] The conventional etching process has the following drawbacks: time consuming, producing thick and sticky precipitate and large amount of wastewater, high cost and low yield rate.

[0007] FIG. 3A to Fig. 3I show the conventional punching method to form holes on an insulation layer.

[0008] As shown in FIG. 3A and FIG. 3B, an adhesive layer 304 is coated on the substrate 302. Then, the substrate 302 coated with the adhesive layer 304 is punched to form holes 306. Next, a copper layer 308 is adhered over the substrate 302 coated with the adhesive layer 304. Then, as shown in FIG. 3E to FIG. 3H, a photo-resistor layer 310 is formed on the copper layer 308. After the photolithography process, including exposing, developing and etching, the pattern of the copper layer 308 is defined. Finally, as shown in FIG. 3I, an insulation adhesive layer 312 is formed on one side of the copper layer for the purpose of protection.

[0009] Compared with the etching process as mentioned before, this punching process is shorter in procedure, no problem of wastewater and lower cost. However, the intervals between each two holes are large and hard to reduce. So that, less holes can be formed in the same area, which therefore influences the precision contact between the printer and the TAB. Further more, the punching step could easily cause the breakage of the substrate and thus reduce the yield and increase the cost.

SUMMARY OF THE INVENTION

[0010] It is therefore an object of the invention to provide a method of fabricating flexible circuit board without having the problems of producing contaminating developer but with the advantages of shorter procedure, lower cost, high hole resolution, and high yield rate, which is suitable for mass production.

[0011] An improved and simplified process of forming a flexible circuit board for ink jetting comprises the steps of: providing an insulation tape; forming conductive traces on the insulation tape; and forming a photo-polymer layer filling between the conductive traces, wherein parts of the conductive traces are exposed to form a plurality of contacts. The material of the insulation tape can be polyimide, Teflon, polyamide, polymethylmethacrylate, polycarbonate, polyester, polyamide polyethylene-terephthalate copolymer, or any combination of the above materials. The material of the photo-polymer layer can be solder mask or polyimide.

[0012] It is another object of the invention to provide a flexible circuit board for ink jetting, comprising: an insulation tape as a substrate; a plurality of conductive traces on the insulation tape; and a photo-polymer layer filling between the conductive traces, wherein parts of the conductive traces are exposed to form a plurality of contacts.

[0013] Other objects, features, and advantages of the invention will become apparent from the following detailed description of the preferred but non-limiting embodiments. The following description is made with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] FIG. 1 (Prior Art) shows a conventional flexible circuit board and its relative position to the dimple of the printer.

[0015] FIG. 2A ~ FIG. 2J (Prior Art) illustrate the conventional etching process.

[0016] FIG. 3A to FIG. 3I (Prior Art) show the conventional punching method to form holes on an insulation layer.

[0017] FIG. 4A to FIG. 4J show a portion of the process of manufacturing the flexible circuit board according to a preferred embodiment of the invention.

[0018] FIG. 5 shows the process of forming, exposing, developing and post-curing the photo-polymer layer.

[0019] FIG. 6 shows the flexible circuit board of the invention and its relative position to the dimple 610 in the printer.

[0020] FIG. 7 shows the flexible circuit board of the invention and the chip.

[0021] FIG. 8 (Prior Art) shows the conventional flexible circuit board and the chip.

DETAILED DESCRIPTION OF THE INVENTION

[0022] FIG. 4A to FIG. 4J show a process of manufacturing the flexible circuit board according to a preferred embodiment of the invention. First, as shown in FIG. 4A and FIG. 4B, an adhesive layer 404 is coated over the insulation tape 402 made of the material such as polyimide (PI). And then, a conductive layer 406, the material of which is such as copper or gold, is formed over the adhesive layer 404. In the

practical application, the conductive layer 406 could be formed by adhering a copper foil or a gold foil on the insulation tape 402. The preferred thickness of the copper foil or the gold foil is at the range of about 10μm to 50μm.

[0023] Next, as shown in FIG. 4C to FIG. 4G, a photo-resistor layer 408 is formed over the conductive layer 406. After defining the conductive layer 406 to a desired pattern, the photo-resistor layer 408 is removed. By now, the insulation tape 402 has conductive traces with a desired pattern on it.

[0024] Next, as shown in FIG. 4H, a photo-polymer layer 410 is formed over the insulation tape 402 with conductive traces 406. Preferably, formation of the photo-polymer layer 410 can be performed by one of screen printing, spray coating, curtain coating and roller coating techniques. The preferred material of the photo-polymer layer 410 can be solder mask. After exposed to the light, solder mask could be crosslinked by radiation. Crosslinked solder mask is strong in structure and insoluble in developer (developing solution), acting just as a negative photo-resistor. Moreover, PR materials having the similar physical and chemical characteristics such as polyimide (PI) and the like are also applicable herein.

[0025] As shown in FIG. 4I and FIG. 4J, a portion of the photo-polymer layer 410 is removed to expose parts of the conductive traces 406 by developing. After a post-curing process, the photo-polymer layer 410 is hardened.

[0026] FIG. 5 shows the process of forming, exposing, developing and post-curing the photo-polymer layer 410. PSR9000 series A01 type photo-solder mask (available

from Taiwan Taiko Ink Corp.) is selected as the preferred material of the photo-polymer layer 410 in the embodiment of the invention. The preferred ratio of the main agent and the hardener is about 7:3. After the photo-polymer layer 410 is coated (step 502), an exposing step 504 is performed. The ideal exposure energy is about 280~420mJ/cm ^{2}. During the developing process 506, 1wt% Na_2CO_3 solution is used as the developer, and the photo-polymer 410 is developed at the temperature lower than 30 ? for about 60~90 sec. At post-curing 508 step, the flexible circuit board is placed at a hot air convention oven at 150 ? for about 50 min.

[0027] Besides polyimide (PI), the material of the insulation tape can be other polymer films such as Teflon, polyamide, polymethylmethacrylate, polycarbonate, polyester, polyamide polyethylene-terephthalate copolymer, or any combination of the above materials.

[0028] Thus, the flexible circuit board fabricated according to the preferred embodiment of the invention has an inventive structure as describe below. Unlike the prior disclosure, the conductive traces 406 and the photo-polymer layer 410 are formed on the same side of the insulation tape 402; also, the photo-polymer layer 410 fills between the conductive traces 406, not completely covering the conductive traces 406. The photo-polymer layer 410 thus forms the holes 420 exposing parts of the conductive traces 406 to form a plurality of contacts (see FIG. 4J). In other words, the photo-polymer layer 410 has the holes 420 formed therein so that parts of the conductive traces 406 are not covered by the photo-polymer layer 410 to form a plurality of uncovered contacts that are exposed by the holes 420.

[0029] Referring to FIG. 1, the conventional dimple 110 of the printer (not shown) contacts with the conductive layer 106 of the flexible circuit board at the other side of the insulation tape 104 through the hole 108. However, the conductive layer 406 of the flexible circuit board of the invention is positioned at the side of the insulation tape 402 near the dimple 610 of the printer. Therefore, it apparently shows that the dimple 610 of the printer contacts the conductive layer 406 more directly and precisely.

[0030] Moreover, the flexible circuit board fabricated according to the invention has the practical advantage of less opportunity of short circuit. Referring to FIG. 7, after the flexible circuit board of the invention adheres to the chip 702, the conductive layer 406 slightly bends because the insulation tape 402 and the chip 702 are at the same side of the conductive layer 406. On the contrary, after the conventional flexible circuit board adheres to the chip 802 as shown in FIG. 8, the conductive layer 208 bends sharply because the insulation tape 202 and the chip 802 are at the opposite sides of the conductive layer 208. With the character of less bending of the conductive layer 406, the flexible circuit board of the invention has the advantage of less opportunity of short circuit.

[0031] Summarily, forming the contacts on the insulation tape according to the preferred embodiment of the invention has the following advantages and inventive features:

[0032] (1) Photo-polymer applied in the invention provides higher conductive

traces density and better coverage than the conventional dry film.

[0033] (2) Solution with weak alkalinity is used as the developer, which is low in cost in terms of reagent and equipments, and causes no environmental pollution.

[0034] (3) The conductive layer hardly bends so that the problem of short circuit is eliminated.

[0035] (4) The configuration of the conductive traces, the photo-polymer layer and the holes are performed at the same sides of the insulation tape.

[0036] (5) The photo-polymer layer fills between the conductive traces, thereby exposing parts of the conductive traces 406 to form a plurality of holes.

[0037] Furthermore, the process of the invention has no require for performing the step of punching holes on the insulation tape; thus, overall manufacturing time is shortened, production cost is decreased, hole resolution is good and production yield is improved (up to 99%). Accordingly, the method provided by the invention is suitable for mass production.

[0038] While the invention has been described by way of an example of manufacturing a flexible circuit board (FCB), it is to be understood TAB device is also within the scope of the invention since FCB is commonly bounded with the chip through a TAB process

[0039] While the invention has been described by way of example and in terms of

a preferred embodiment, it is to be understood that the invention is not limited thereto. On the contrary, it is intended to cover various modifications and similar arrangements and procedures, and the scope of the appended claims therefore should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements and procedures.